"A MOTOR VEHICLE SAFETY DEVICE"

THE PRESENT INVENTION relates to a safety device for a motor vehicle, and more specifically to a motor vehicle safety device incorporating an inflatable curtain.

When a motor vehicle is involved in an accident there is a risk that the driver and passengers within the vehicle will be injured. It has been proposed to provide vehicles with safety devices to reduce the risk of such injury.

Certain safety devices are intended to provide protection in the case of a side impact. European Patent EP-A-0808257 discloses such a device, in which an inflatable element is provided which is initially stored in position in a recess in a door frame of the vehicle. There is provided a gas generator which is adapted to generate gas, such as cold gas, the gas generator incorporating a sensor which senses a side impact and/or roll-over situation and subsequently activates the gas generator at an appropriate instant. The gas generator is connected to the inflatable element, and when a side impact occurs the gas generator generates cold gas which inflates the inflatable element. The inflatable element thus moves from its initial stored position, within the recess

in the door frame, to the operative position, where it forms a substantially flat curtain located between the head of the person and the adjacent window.

A problem associated with such side impact safety devices is that of providing a tensioning means for the inflatable element when it is in an operable position, so that it offers sufficient protection against the head of a person passing through the window. In the case of EP-A-0808257, where the recess in which the inflatable element is initially stored spans at least one of the "A" and "C" posts of the vehicle such that it is non-linear, the inflatable element is separated into a plurality of vertical cells. Upon inflation, the lower edge of the inflatable element is thus decreased in length which, as a result of the upper edge of the inflatable element being fixedly attached to the non-linear door frame, creates a tension in the lower edge of the inflatable element, holding the inflatable element in place and offering protection for the passenger in a roll-over situation.

US 6241277 discloses an arrangement for tensioning a side airbag when the recess in the door frame in which the airbag is initially stored is substantially linear. Two pulleys are provided, one fixed to the door frame of the motor vehicle, above the recess in which the airbag is initially stored, and the other fixed to a point on the motor vehicle in a position in front of the leading edge of the airbag. A cord is attached, at one end, to the leading edge of the airbag and, at the other end, to a point on the airbag positioned rearwardly of the leading edge. The cord is substantially inextensible except for an elastic portion which is initially under little or no tension. During a side impact situation, the airbag is inflated downward toward the base of the window of the motor vehicle and the cord and pulley system are positioned such that, as the airbag moves downwardly, tension is created in the elastic

portion of the cord, the tension having a component along the lower edge of the airbag as desired.

It is an object of the present invention to provide an improved safety device incorporating a tensioning system for tensioning an inflatable curtain.

According to one aspect of the present invention there is provided a safety device for a motor vehicle comprising an inflatable curtain having an upper edge and a lower edge, the upper edge being adapted to be mounted within the interior of a motor vehicle, a first portion of elongate, flexible element being attached to and extending from a point on said inflatable curtain, a second portion of elongate flexible element being attached to and extending from a point on said inflatable curtain, said first portion of elongate, flexible element incorporating a slide member adapted to slidably retain a length of said second portion of elongate, flexible element.

Preferably, the first and second portions of elongate, flexible element are separate portions of a single elongate, flexible element.

Conveniently, the first and second portions of elongate, flexible element are attached to said inflatable curtain at a common point.

Preferably, the first and second portions of elongate, flexible element are each attached to a point on said inflatable curtain which is in the region of said lower edge.

Conveniently, the member adapted to slidably retain a length of said second portion of elongate, flexible element is in the form of a rigid ring.

In a preferred embodiment, one of the portions of elongate flexible element is elastic.

Preferably, both of the portions of elongate flexible element are elastic.

In another preferred embodiment, both of the portions of elongate flexible element are inextensible.

Conveniently, the point of attachment of one of the portions of elongate flexible element to the inflatable curtain is in the form of an elastic connection.

Preferably, the point of attachment of both portions of elongate flexible element to the inflatable curtain is in the form of an elastic connection.

In another preferred embodiment, the device is mounted within a motor vehicle, the upper edge of the inflatable element being mounted to the vehicle, the first elongate flexible element portion engaging with a first guide element fixed to a point within the motor vehicle, the second elongate flexible element being further attached to a fixed point within said motor vehicle, said fixed point being below said first guide element, the slide member slidably retaining said second portion of elongate flexible element, wherein;
upon inflation of said inflatable curtain, said lower edge moves to a position below said guide element and said portions of elongate flexible element thereby create tension along a line of said inflatable curtain, between said portions and a securing point for the inflatable curtain.

Preferably, the device further comprises a second guide element positioned within the motor vehicle at a point below said first guide element,

said second guide element engaging with said second portion of elongate flexible element between said slide member and inflatable curtain.

In order that the invention may be more readily understood, and so that further features thereof may be appreciated, the invention will now be described by way of example with reference to the accompanying drawings in which:

FIGURE 1 is a diagrammatic side view of a safety device according to one aspect of the present invention with the inflatable curtain in an undeployed state,

FIGURE 2 is a view corresponding to Figure 1 showing the inflatable curtain in a deployed state,

FIGURE 3 is a view corresponding to Figure 1 showing a safety device in accordance with a further aspect of the present invention, with the inflatable curtain in an undeployed state, and

FIGURE 4 is a view corresponding to Figure 3 with the inflatable curtain in a deployed state.

Referring now to Figures 1 and 2, an airbag 1 is in the form of an inflatable curtain, of generally rectangular form. An upper edge 2 of the inflatable curtain is attached to part of the door frame 13 of a vehicle, extending above the doors. A lower edge 4 of the inflatable curtain runs substantially parallel to the lower edge of the door frame 13.

Fixedly attached to the inflatable curtain 1, at a single fixing point 3, which is adjacent the lower edge of the inflatable curtain 1 is an intermediate

part of an elongate flexible element, preferably in the form of a substantially inextensible cord 5, which may be formed from a strong material, with a high tensile strength, such as nylon. From the fixing point 3, a first portion of the cord 5 extends toward a first guide element, preferably in the form of an upper pulley 8, which is mounted adjacent the upper edge of the inflatable curtain and, after passing over the pulley 8, hangs down. The first portion terminates with a slide member in the form of a ring 10. A second portion of the cord 5 depends from the lower edge 4 of the inflatable curtain 1 towards a second guide element, which is preferably in the form of a lower pulley 11, and, after passing around the pulley 11 extends through the ring constituting the slide member at the end of the first cord portion. The second cord portion terminates at an end 6 which is fixedly attached to an anchoring point (shown schematically at 7) mounted on the motor vehicle.

The ring is dimensioned to receive the cord 5 there through and is in slideable, low friction engagement with the portion of the cord 5 between fixing point 3 lower pulley 11. The position of the fixing point 3, pulley 11, anchoring point 7, ring 10 and pulley 8 is such that initially the cord 5 lies substantially in a single plane, perpendicular to the roof of the motor vehicle (not shown).

A retaining element, preferably in the form of a clip 12, may be used to hold the cord 5 in a desired position prior to deployment of the airbag, for example to keep the cord out of view within the "B" or "C" post. The clip may take on various forms provided that it holds the cord 5 in place with sufficient force to prevent the cord breaking free upon jolting of the vehicle, but will release the cord on deployment of the inflatable curtain.

In the described embodiment of the invention, the fixing point 3 for the cord portions on the inflatable curtain is offset from a notional line joining the

upper pulley and the lower pulley. The notional line passes adjacent one end of the inflatable curtain. The lower edge of the inflatable curtain at the other end thereof (not shown) is connected to a securing point.

Referring now to Figure 2, upon deployment of the inflatable curtain, the lower edge of the inflatable curtain 1 moves downwardly, as indicated by the arrow, with the force of the inflating curtain being sufficient to detach the clip 12, and hence cord 5, from the door frame of the motor vehicle. As the lower edge of the inflatable curtain 1 moves in a downward direction, the fixing point 3 is likewise moved in a downward direction causing the first portion of the cord 5 between fixing point 3 and ring to be pulled over pulley 8 and consequently displacing the ring 10 upwardly as indicated by the arrow in Figure 2. Upon this upward displacement of the ring 10, the length of the second portion of cord between the cord and the ring is increased. The resultant effect is that the second portion of cord is pulled past the second lower pulley at almost twice the rate that the ring 10 rises.

Referring again to Figure 2, it can be seen that the total length of the portions of cord 5 is such that, when the inflatable curtain is fully extended in a downward direction, any slack between ring 10, pulley 11 and fixing point 3 is totally eliminated creating a tension T_1 along the section of cord 5 between fixing point 3 and pulley 11. The tension T_1 extends downwardly with an inclination towards the lower pulley 11. In addition, the portion of cord 5 between ring 10 and fixing point 3 which passes over pulley 8 is held taut producing a tension T_2 in a direction along cord 5 upwardly from the fixing point with an inclination towards the upper pulley 8. It will be appreciated, upon resolving forces T_1 and T_2, that there will be a resultant tension T, acting along the lower edge of the inflatable curtain 1, applied to the fixing point 3 by the portion of cord. The creation of tension T along the lower edge of

inflatable curtain 1, will, because the opposite end thereof is secured to a securing point, establish a line of tension which will help to maintain the inflatable curtain 1 in position and prevent the head of the passenger of the motor vehicle passing through the window of the motor vehicle.

The tensioning system described above provides an almost immediate response to the inflation of the inflatable curtain 1, which inflation typically occurs over a time period of around 10 - 15 ms, the inflatable curtain 1 being placed under the required tension as soon as it reaches its fully extended position. The ability to tension the inflatable curtain very rapidly upon full inflation is important for providing maximum protection to the relevant passenger in the motor vehicle.

It will be appreciated that the precise form of the tensioning arrangement may be varied while still providing the sufficient tension along the lower edge of the inflatable curtain 1. The fixing point 3 can be positioned at a number of points along the lower edge 4 of inflatable curtain 1 and may even be positioned at some point on the inflatable curtain 1 above the lower edge. However, the positioning of the fixing point 3 at a level above the lower edge of inflatable curtain 1 would result in an un-tensioned portion of the airbag 1 between the lower edge and fixing point 3 which may be undesirable.

It is to be understood that the precise form of the fixing point 3 may be varied, provided it ensures secure connection of the cord to the inflatable curtain as required. For example, the fixing point may be in the form of a fabric loop which is sown into the inflatable curtain and which is dimensioned to receive the cord in a friction-fit fashion. The cord may also be provided with stops either side of the fabric loop, which are dimensioned so that they cannot pass through the loop, to prevent movement of the cord through the loop

relative to the inflatable curtain. In another contemplated embodiment, fixing point 3 may be in the form of an elastic connection which provides an elastic connection between the cord and inflatable curtain. In the case where two separate cords are used, one cord may be elastically connected to the inflatable curtain or both cords may be elastically connected to the inflatable curtain.

It will also be appreciated that pulley 11 may be positioned at a number of points, provided that it is below the level of pulley 8 and below the level of fixing point 3 when the airbag is fully extended. Indeed, the inclusion of pulley 11 is not essential to the effective working of the present invention.

Thus, in another preferred embodiment, shown in Figure 3, there is provided a tensioning arrangement similar to that shown in Figure 1. The arrangement differs from that shown in Figure 1 in that there is only one guide element, namely pulley 8.

Upon inflation of inflatable curtain 1 of figure 3 (Figure 4), fixing point 3 moves downwardly with the lower edge of the inflatable curtain, which consequently causes ring 10 to be displaced upwardly, as previously described in connection with the embodiment shown in Figure 1. However, in contrast to the embodiment shown in Figure 1, displacement of the ring 10 from an initial position below the anchoring point 7 to a point significantly higher than the anchoring point 7 creates a direct line of tension between fixing point 3 and ring 10, indicated as T_1 in Figure 4. Upon resolving the line of tension T_1, along with tension T_2 created as aforedescribed with reference to figure 1, it will be appreciated that there is a resultant component of tension which extends between T_1 and T_2. This co-operates with a downward force created by the downward movement of the lower edge of the inflatable curtain to provide a generally horizontal tension T in the lower edge of the inflatable curtain.

The precise position of anchoring point 7 may be varied without compromising the effective working of the invention, provided always that the anchoring point is positioned sufficiently below the level of the pulley 8. For example, with reference to figures 3 and 4, the anchoring point 7 may be positioned so that, upon inflation of the inflatable curtain, it is located higher than the fixing point 3. It will be appreciated that the position of anchoring point 7 is a compromise between, on the one hand, minimising the slack in the cord 5 when the inflatable curtain is an undeployed state (so as to facilitate easy discrete storage of the cord in the frame of the vehicle) and, on the other hand, minimising the amount of slack to be taken up, thereby decreasing the time taken to tension the inflatable curtain.

The embodiment shown in Figures 1 and 2 incorporates a single cord 5, but it is envisaged that the invention would work equally effectively with two separate portions of cord, the first portion of cord extending from fixing point 3, around pulley 8, and terminating in ring 10 and the second portion of cord extending from fixing bracket 7, passing through ring 10 and being fixed at its other end to fixing point 3. Indeed, where two portions of cord are used, they need not both be attached to fixing point 3, but rather may be attached to the lower edge of the inflatable curtain at separate points adjacent the lower edge. Furthermore, although the preferred embodiments described herein, by way of example and with reference to the accompanying drawings, utilise inextensible cord, it is to be understood that strong elastic cord, whether in the form of a single elastic cord or two separate elastic cords, may equally be used. Indeed, in the case where two separate cords are employed, one of the cords may be elastic and the other inextensible.

Although the embodiment shown in Figures 1 and 2 shows the use of a pulley 8, and a second pulley 11, which act as guide elements, it is envisaged that a wide variety of guide elements may be employed in place of such a pulley, it only being necessary that the cord pass around and engage with the guide element such that the cord may slide relatively freely around the external surface of the guide element. In its simplest form, the guide elements may be in the form of rigid projecting elements around which the cord 5 may pass.

In the present Specification "comprises" means "includes or consists of" and "comprising" means "including or consisting of".